Synopsys 90nm Reference PDK

Data Book, March 2010

SYNOPSYS®

Contents

About This Manual

The document discusses the details of the Synopsys Reference PDK Data Book. PDK stands for Process Design Kit. It contains the Custom Designer symbol library, python pcells, technology file, Hercules DRC and LVS runsets, Synopsys Reference HSPICE models, and StarRC related files.

This manual covers the following topics:

- [Installation and Initialization](#)
- [Devices Supported in this PDK](#)
- [Technology File Overview](#)
- [Additional Information](#)

Conventions

The following conventions are used in Synopsys documentation.

Convention	Description
Courier	Indicates command syntax.
Italic	Indicates a user-defined value, such as *object_name*
Purple	Within an example, indicates information of special interest. Within a command-syntax section, indicates a default value, such as: `include_enclosing = ` **true** `	false`
Bold	Within syntax and examples, indicates user input—text you type verbatim. Indicates a graphical user interface (GUI) element that has an action associated with it
[]	Denotes **o**ptional parameters, such as: `write_file [-f filename]`
...	Indicates that parameters can be repeated as many times as necessary: `pin1 pin2 ... pinN`
|	Indicates a choice among alternatives, such as `low	medium	high`
\	Indicates a continuation of a command line
/	Indicates levels of directory structure

Edit > Copy	Indicates a path to a menu command, such as opening the Edit menu and choosing Copy
Ctrl+C	Indicates a keyboard combination, such as holding down the Ctrl key and pressing the C key

Customer Support

Customer support is available through SolvNet online customer support and through contacting the Synopsys Technical Support Center.

- Accessing SolvNet
- Contacting the Synopsys Technical Support Center

Accessing SolvNet

SolvNet includes an electronic knowledge base of technical articles and answers to frequently asked questions about Synopsys tools. SolvNet also gives you access to a wide range of Synopsys online services, which include downloading software, viewing Documentation on the Web, and entering a call to the Support Center.

To access SolvNet:

Go to the SolvNet Web page at http://solvnet.synopsys.com.

If prompted, enter your user name and password. (If you do not have a Synopsys user name and password, follow the instructions to register with SolvNet.)

If you need help using SolvNet, click Help on the SolvNet menu bar.

Contacting the Synopsys Technical Support Center

If you have problems, questions, or suggestions, you can contact the Synopsys Technical Support Center in the following ways:

Open a call to your local support center from the Web by going to http://solvnet.synopsys.com/EnterACall (Synopsys user name and password required).

Send an e-mail message to your local support center.

E-mail support_center@synopsys.com from within North America.

Find other local support center e-mail addresses at http://www.synopsys.com/support/support_ctr.

Telephone your local support center.

Call (800) 245-8005 from within the continental United States.

Call (650) 584-4200 from Canada.

Find other local support center telephone numbers
     at http://www.synopsys.com/support/support_ctr.

Installation and Initialization

This section contains the following topics:

- [Installing the PDK](#)
- [Installing Ciranova Pycell Studio](#)
- [Understanding the PDK Installation Directory Structure](#)

Installing the PDK

To install the PDK, unzip the PDK .tar.gz file by issuing the following command:

```
tar -xzf snps_reference90RF_25MAR10.tar.gz
```

The contents of the .tar.gz file is extracted to the location ./snps_reference90/25MAR10:
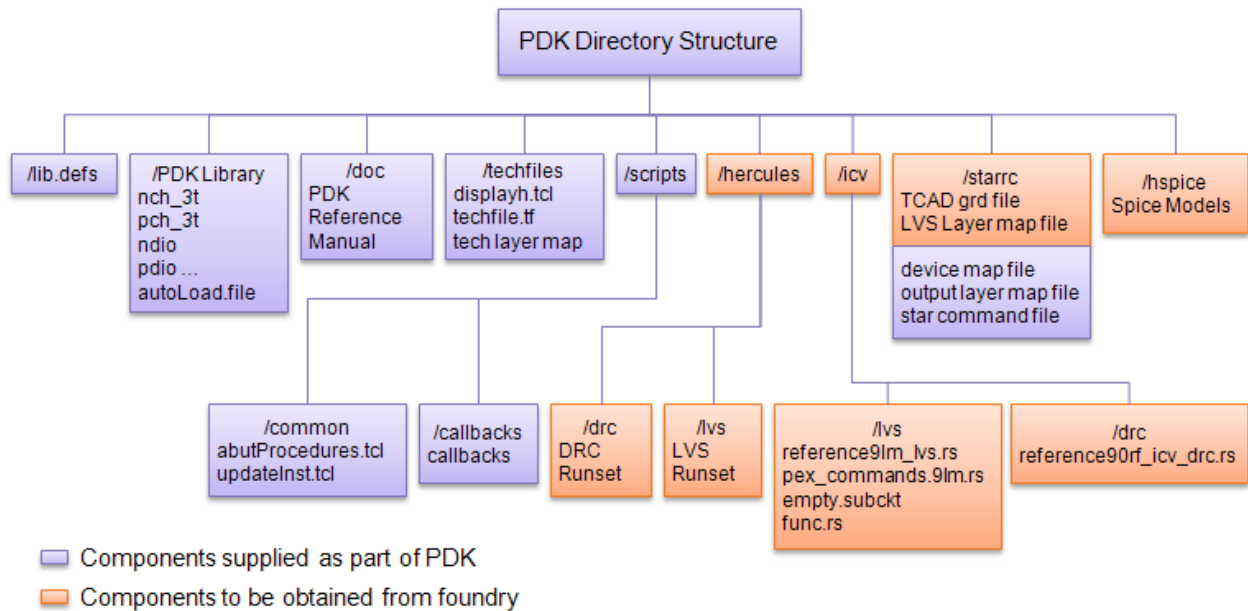
This section covers the following topics:

- [Foundry References](#)
- [Synopsys Tools Compatibility Matrix](#)

Foundry References

The following documentation resources are provided with this PDK:

Resource	Document Location
SPICE Models	reference_models.inc, 01 Mar 2010
Design Rule Specifications	ReferenceKit_DesignRules.pdf
Hercules LVS runset	reference_lvs.ev, 02 Mar 2010
Hercules DRC runset	reference_drc.ev, 02 Mar 2010
ICV LVS runset	reference9lm_lvs.rs, 03 March 2010
ICV DRC runset	reference90rf_icv_drc.rs, 03 March 2010
StarRC	reference_90nm_9lm_typ.nxtgrd, 06 Apr 2009, 20:59:52
	starrc_mapping_9lm

Synopsys Tools Compatibility Matrix

The following table lists the Synopsys tools compatibility matrix:

Product	Release
Custom Designer	D-2009.12-SP1
Hercules	2008.09-SP1-2
ICV	2009.12-1
HSPICE	2009.09-SP1
StarRC	2009.12-SP1

Installing Ciranova Pycell Studio

The pcells in the PDK are developed using APIs from Ciranova. Before you are able to work with these pcells, you will have to set up Ciranova APIs.

Depending on the type of machine on which you would be using the PDK, you will have to download a particular version of the Ciranova Pycell Studio:

If you want to use the PDK on a …	then download and install…
UNIX/LINUX 32-bit machine	Ciranova Pycell Studio, 32-bit version 4.3.4_PY2.6.2
UNIX/LINUX 64-bit machine	Ciranova Pycell Studio, 64-bit version 4.3.4_PY2.6.2

Follow this procedure to set up Ciranova APIs:

1. Download the appropriate Ciranova Pycell Studio
    from http://www.ciranova.com/downloads/,
2. Install and source the `tcshrc/bashrc` scripts available in the quickstart
    folder in the Ciranova installation directory.

Understanding the PDK Installation Directory Structure

When you extract the contents of the PDK .tar.gz file, the following files and
folders are created:

- 25MAR10/lib.defs
- 25MAR10/techfiles
- 25MAR10/scripts/callbacks
- 25MAR10/scripts/common
- 25MAR10/doc
- 25MAR10/hercules/lvs
- 25MAR10/hercules/drc
- 25MAR10/icv/lvs
- 25MAR10/icv/drc
- 25MAR10/starrc
- 25MAR10/hspice
- 25MAR10/reference90RF (library)

25MAR10/lib.defs

The `lib.defs` file contains a reference to this PDK such that the contents of
the PDK are available from within Custom Designer.

25MAR10/techfiles

This directory contains the following technology and display resource files:

Files	Description
`reference90RF_9lm.tf`	This file is used for library creation for the reference process. The file contains layer information and design rule definitions.

`reference90RF_layer.map`	This file maps the layer name with the layer purpose, layer number and layer data type.
`display.tcl`	This file contains the color, fill, and stipple patterns for all the packets used in the technology file.
`display.drf`	This file contains the color, fill, and stipple patterns for all the packets used in the technology file.

25MAR10/scripts/callbacks

This directory contains the callbacks used to validate user inputs and perform parameter range checks by comparing them with the values in the `DesignRules.tcl` file.

The callbacks scripts calculate and update the values in the Property Editor Form, and produce warning messages in the Custom Designer console.

The callbacks functional flow is as follows:
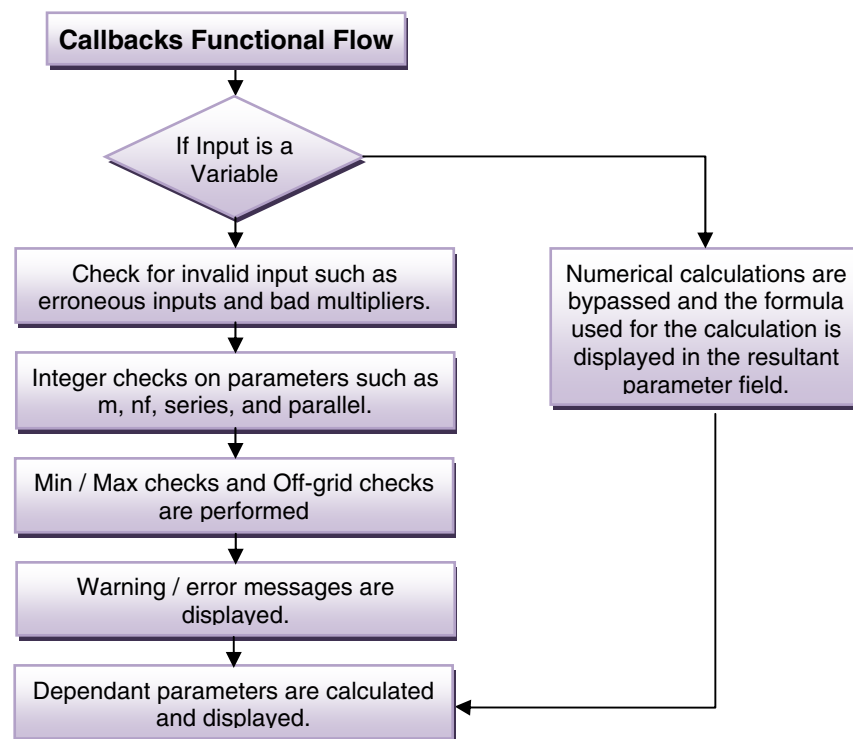
Callback Scripts	Description
`ref90_common.tcl`	Contains common procedures used by multiple devices.
`mos_reference90RF_cbk.tcl`	MOSFET callback script
`cap_reference90RF_cbk.tcl`	Capacitor callback script

Callback Scripts	Description
`dio_reference90RF_cbk.tcl`	Diode callback script
`res_reference90RF_cbk.tcl`	Resistor callback script
`cust_reference90RF_cbk.tcl`	Custom vias callback script
`iPDK_snps.tcl`	Contains Custom Designer specific commands. This file must be modified appropriately and commands replaced by equivalent commands present in the environment this PDK intends to be used in

25MAR10/scripts/common

This directory contains the following PDK sourcing and utility scripts:

Scripts	Description
updateInst.tcl	This procedure runs the callbacks on all the pcell and symbol instances and updates the values as per the latest callbacks
`abutProcedures.tcl`	This file contains MOSFET abutment related procedures

25MAR10/doc

This directory contains the Reference 90 RF PDK reference manual.

25MAR10/hercules/lvs

This directory contains the Hercules LVS runset and the empty sub-circuit file for use with the lvs netlist.

25MAR10/hercules/drc

This directory contains the Hercules DRC runset.

25MAR10/icv/lvs

This directory contains the ICV LVS runset, empty sub-circuit file and the other related files for lvs.

25MAR10/icv/drc

This directory contains the ICV DRC runset.

25MAR10/starrc

This directory contains the following files:

File	Description
device_map	This file maps the devices extracted by StarRC with the ivpcells to be used for each device in the starrc view produced after running StarRC
output_layer_map	This file maps the LVS runset layers onto the technology file LPPs for use in the starrc view produced
star_herc_cmd	This is a sample StarRC command file for Hercules
star_icv_cmd	This is a sample StarRC command file for ICV
reference_90nm_9lm_typ.nxtgrd	NXTGRD file
starrc_mapping_9lm	This file maps the LVS Runset layers onto the NXTGRD layers
reference_9lm.itf	Interconnect Technology File

25MAR10/hspice

This directory contains the HSPICE models file.

25MAR10/reference90RF (library)

The directory contains cells and each cell[1] contains the following six views of each device:

View	Description
symbol	This view contains the symbol shape and connectivity information
layout	This view contains the pcell super master
hspice	This view is used for netlisting purpose
Ivpcell	This view is used for parasitic view and parasitic re-simulation.
auCdl	This view is used for auCdl Netlisting
auLvs	This view is used for auLvs Netlisting

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[1] Except the custom vias which have only layout view Ex: diff_cust, poly_cust.

Devices Supported in this PDK

The following devices are bundled in this PDK:

- [MOSFET](#)
- [Resistors](#)
- [Capacitors](#)
- [Diodes](#)
- [Custom Vias](#)

MOSFETs

The following 3 and 4 terminal MOSFETs are supported in this PDK:

Device	SPICE Model	Description
n_3t	N	3-term (D G S) 1 Volt MOSFET
n_4t	N	4-term (D G S B) 1 Volt MOSFET
n18_3t	N18	3-term (D G S) 1.8 Volt MOSFET
n18_4t	N18	4-term (D G S B) 1.8 Volt MOSFET
na_3t	NA	3-term (D G S) 1 Volt Native Oxide MOSFET
na_4t	NA	4-term (D G S B) 1 Volt MOSFET
na18_3t	NA18	3-term (D G S) 1.8 Volt Native Oxide MOSFET
na18_4t	NA18	4-term (D G S B) 1.8 Volt MOSFET
nh_3t	NH	3-term (D G S) High threshold Voltage MOSFET
nh_4t	NH	4-term (D G S B) High threshold Voltage MOSFET
nl_3t	NL	3-term (D G S) Low threshold Voltage MOSFET
nl_4t	NL	4-term (D G S B) Low threshold Voltage MOSFET
nm_3t	NM	3-term (D G S) Medium threshold Voltage MOSFET
nm_4t	NM	4-term (D G S B) Medium threshold Voltage MOSFET
p_3t	P	3-term (D G S) 1 Volt MOSFET
p_4t	P	4-term (D G S B) 1 Volt MOSFET
p18_3t	P18	3-term (D G S) 1.8 Volt MOSFET
p18_4t	P18	4-term (D G S B) 1.8 Volt MOSFET
ph_3t	PH	3-term (D G S) High threshold Voltage MOSFET

Device	SPICE Model	Description
ph_4t	PH	4-term (D G S B) High threshold Voltage MOSFET
pl_3t	PL	3-term (D G S) Low threshold Voltage MOSFET
pl_4t	PL	4-term (D G S B) Low threshold Voltage MOSFET
pm_3t	PM	3-term (D G S) Medium threshold Voltage MOSFET
pm_4t	PM	4-term (D G S B) Medium threshold Voltage MOSFET

This section covers the following topics:

- [MOSFET CDF Parameters](#)
- [Units](#)
- [Parametric Inputs/Values](#)
- [MOSFET Netlist](#)
- [MOSFET Device Specifications](#)

MOSFET CDF Parameters

The following table lists the CDF parameters and their description:

Parameter Name	Parameter Prompt	Description
model	Spice Model	Hspice model name
lvs_model	LVS Model	LVS model name.
w	Width per Finger (M)	Width per finger
wtot	Total Width (M)	Total width of Mosfet
l	Length (M)	Length of each finger of Mosfet
entryMode	Entry Mode	Width per finger / Total width
nf	Number of fingers	Number of fingers of poly gate.
swapTerminal	swapTerminal	Option to swap the source/drain terminals.
drainTerm	Right Terminal	Check to draw drain terminal
sourceTerm	Left Terminal	Check to draw source terminal.
strapSource	Strap Source	Option to strap the source terminals

Parameter Name	Parameter Prompt	Description
strapDrain	Strap Drain	Option to strap the drain terminals
internalStrapping	Connect S/D[2] Regions	Allows the functioning of Strap Source and Strap Drain Parameters.
keepOut	Keep Out	Check to draw "routeGuide" layer for metal blockage while auto-routing over mosfets.
gateStrapTop	Top Gate Strap Layer	Options to select the layer with which the gates are to be strapped on the top
gateStrapBottom	Bottom Gate Strap Layer	Options to select the layer with which the gates are to be strapped on the bottom
tapStructure	Tap Structure	Tap or bulk placement with respect to mosfet in layout. Options: standard, ring.
		This option works in tandem with bottom 6 properties.
tapIncrSpacing	Tap Spacing (M)[3]	Controls distance of tap diffusion from Mosfet diffusion. Value entered is incremental, i.e. value directly added minimum DRC allowed value and does not indicate actual value.
tapContacts	Tap Contacts[4]	Specify number of rows (top and bottom) or columns (left and right) of contacts.
		For "standard" tapStructure, this is fixed to single row/column.
tapTop	Place Tap on Top	Controls top-tap structure.
		Options: none, diffusion (draws diff and implant), all (draws diff, implant, contact and metal1).
		If Tap Structure is set to "standard", then "diffusion" sub-option is not allowed.

[2] Parameter will be visible when Number of Fingers > 1

[3] Parameter will not be visible unless Tap Contacts > 1.

[4] Parameter will be not be visible in the form if tap options are set to "none" .

Parameter Name	Parameter Prompt	Description
tapBottom	Place Tap on Bottom	Controls bottom-tap structure.
		Options: none, diffusion (draws diff and implant), all (draws diff, implant, contact and metal1).
		If Tap Structure is set to "standard", then "diffusion" sub-option is not allowed.
tapLeft	Place Tap on Left	Controls left-tap structure.
		Options: none, diffusion (draws diff and implant), all (draws diff, implant, contact and metal1).
		If Tap Structure is set to "standard", then "diffusion" sub-option is not allowed.
tapRight	Place Tap on Right	Controls right-tap structure.
		Options: none, diffusion (draws diff and implant), all (draws diff, implant, contact and metal1).
		If Tap Structure is set to "standard", then "diffusion" sub-option is not allowed.
leftButtedTap	Butting of Left Tap[5]	Option to have butted MOS tap structure. Selecting this option will butt the mosfet and left tap diffusion layers.
rightButtedTap	Butting of Right Tap[5]	Option to have butted MOS tap structure. Selecting this option will butt the mosfet and right tap diffusion layers.
buttedTapMetal	Strap Bulk and Mos Metals	This option connects the source/drain metal1 with the tap metal1 layer
drawWell	Draw Nwell	Check to draw Nwell layer for P type MOS
drawImplant	Draw Implant	Check to draw Implant layer.
m	Multiplier	Multiplicity factor to place "m"

---

[5] Parameter will be visible only when Tap Structure set to "standard" and "Place Tap on Left"/ "Place Tap on Right" set to all/diffusion

Parameter Name	Parameter Prompt	Description
		number of parallel devices , available only in schematic view
p2cs	Gate to Source Contact Spacing (M)	Source contact to gate spacing. Value cannot be less than gate-poly to contact spacing defined in Design Rules Manual.
p2cd	Gate to Drain Contact Spacing (M)	Drain contact to gate spacing. Value cannot be less than gate-poly to contact spacing defined in Design Rules Manual.
parasiticsMode	Parasitics Mode	Option to select either of "value" or "manual" modes. Value mode calculates the various mos parasitics and manual mode will let the user enter custom parasitic values.
ad	Drain Diffusion Area (Sq.M)	Area of drain
as	Source Diffusion Area (Sq.M)	Area of source
pd	Drain Diffusion Periphery (M)	Perimeter of drain
ps	Source Diffusion Periphery (M)	Perimeter of source
nrd	Drain Diff Resistor Sq	Number of squares of resistances for drain
nrs	Source Diff Resistor Sq	Number of squares of resistances for source
sa	Gate to Left Edge of Diff-SA (M)	Length of left most edge of diffusion to left most edge of first gate .For more details refer figure 1 on page no .25
sb	Gate to Right Edge of Diff-SB (M)	Length of right most edge of diffusion to right most edge of first gate. For more details refer figure 1 on page no .25
sd	Avg Diff Length between Gates-SD (M)	Average diffusion length for a multi fingered MOSFET. (Excluding leftmost and rightmost diffusion). For more details refer figure 1 on page no .25

Parameter Name	Parameter Prompt	Description
DFMRules	DFM Rules	Option to select the minimum , recommended or custom DFM rules for the mosfet layout
polyDiffEndcap	Poly Diffusion Endcap (M)	Value of Poly gate extension beyond diffusion
diffPolyEndcap	Diffusion Poly Endcap (M)	Value of Diffusion enclose poly gate along the length of the mosfet.
m1ContactEndcap	Metal1 Contact Endcap (M)	Value of Metal 1 endcap enclosure of contact
diffPolySpacing	Diffusion Poly Spacing (M)	Value of Diffusion to poly spacing
diffContactEnclose	Diffusion Contact Enclose (M)	Value of Diffusion enclose contact
polyContactEndcap	Poly Contact Endcap Enclose (M)	Value of poly endcap enclosure of contact
abutInputsL	abutInputsL	This is an invisible CDF used to pass abutment triggers for drawing the left diffusion from the tools to P-cell code.
abutInputsR	abutInputsR	This is an invisible CDF used to pass abutment triggers for drawing the right diffusion from the tools to P-cell code.
m1StrapWidth	M1 Strap Width	Width of metal1 used for strapping sources/drains

Units

By default, the units for the values entered for length and width are meters. The unit name postfixes are taken care of by Custom Designer.

Parametric Inputs/Values

All values entered must be integers or floating-point numbers or variables.

MOSFET Netlist

The following table illustrates the 3 and 4 terminal MOSFET netlist:

Device Type	No. of Terminals	Netlist
'N' Channel	3-Terminal	`m4 net20 net22 net21 gnd! N w='0.19u' l='0.1u' nf=1 m=1 ad='41.8f' as='41.8f' pd='0.63u' ps='0.63u' nrd=1.15789 nrs=1.15789 sa='0.22u' sb='0.22u' sd='0u`
	4-Terminal	`m5 net23 net26 net25 net24 N w='0.19u' l='0.1u' nf=1 m=1 ad='41.8f' as='41.8f' pd='0.63u' ps='0.63u' nrd=1.15789 nrs=1.15789 sa='0.22u' sb='0.22u' sd='0u'`
'P' Channel	3-Terminal	`m21 net76 net77 net75 vdd! P w='0.19u' l='0.1u' nf=1 m=1 ad='41.8f' as='41.8f' pd='0.63u' ps='0.63u' nrd=1.15789 nrs=1.15789 sa='0.22u' sb='0.22u' sd='0u'`
	4-Terminal	`m22 net80 net81 net78 net79 P w='0.19u' l='0.1u' nf=1 m=1 ad='41.8f' as='41.8f' pd='0.63u' ps='0.63u' nrd=1.15789 nrs=1.15789 sa='0.22u' sb='0.22u' sd='0u'`

MOSFET Device Specifications

The following table lists the permissible range of the CDF parameters:

Device	Length in µm		Width in µm	
	Min	Max	Min	Max
n_3t	0.1	20	0.12	900
n18_3t	0.28	900	0.4	900
na_3t	0.2	20	0.5	900
na18_3t	1.2	900	0.5	900
nl_3t	0.15	20	0.3	900
nm_3t	0.15	20	0.3	900
nh_3t	0.15	20	0.3	900
p_3t	0.1	20	0.12	900
p18_3t	0.28	900	0.4	900
pl_3t	0.15	20	0.3	900

Device	Length in µm		Width in µm	
	Min	Max	Min	Max
pm_3t	0.15	20	0.3	900
ph_3t	0.15	20	0.3	900
n_4t	0.1	20	0.12	900
n18_4t	0.28	900	0.4	900
na_4t	0.2	20	0.5	900
na18_4t	1.2	900	0.5	900
nl_4t	0.15	20	0.3	900
nm_4t	0.15	20	0.3	900
nh_4t	0.15	20	0.3	900
p_4t	0.1	20	0.12	900
p18_4t	0.28	900	0.4	900
pl_4t	0.15	20	0.3	900
pm_4t	0.15	20	0.3	900
ph_4t	0.15	20	0.3	900

See Also

[MOSFET: mos_reference90RF_cbk.tcl](#) in the Warnings and Error Messages section.

Resistors

The following resistors (6 resistors and 9 metal resistors) are supported in this PDK:

Device	Symbol / Pcell	Spice Model	Description
rm1	rm1	rm1	2 terminal (PLUS MINUS) metal1 resistor
rm2	rm2	rm2	2 terminal (PLUS MINUS) metal2 resistor
rm3	rm3	rm3	2 terminal (PLUS MINUS) metal3 resistor
rm4	rm4	rm4	2 terminal (PLUS MINUS) metal4 resistor
rm5	rm5	rm5	2 terminal (PLUS MINUS) metal5 resistor
rm6	rm6	rm6	2 terminal (PLUS MINUS) metal6 resistor
rm7	rm7	rm7	2 terminal (PLUS MINUS) metal7 resistor

Device	Symbol / Pcell	Spice Model	Description
rm8	rm8	rm8	2 terminal (PLUS MINUS) metal8 resistor
rmt	rmt	rmt	2 terminal (PLUS MINUS) metal top resistor
rndiff	rndiff	rndiff	2 terminal (PLUS MINUS) N+ diffusion unsalicided resistor
rnpoly	rnpoly	rnpoly	2 terminal (PLUS MINUS) N+ poly unsalicided resistor
rnwdiff	rnwdiff	rnwdiff	2 terminal (PLUS MINUS) NWELL unsalicided resistor
rnwell	rnwell	rnwell	2 terminal (PLUS MINUS) NWELL salicided resistor
rpdiff	rpdiff	rpdiff	2 terminal (PLUS MINUS) P+ diffusion unsalicided resistor
rppoly	rppoly	rppoly	2 terminal (PLUS MINUS) P+ poly unsalicided resistor

This section covers the following topics:

- [Resistor CDF Parameters](#)
- [Units](#)
- [Parametric Inputs/Values](#)
- [Resistor Netlist](#)
- [Resistor Device Specifications](#)

Resistor CDF Parameters

The following table lists the CDF parameters and their description:

Parameter Name	Parameter Prompt	Description	Resistor Type		
			Metal	Poly Diffusion	Nwell
model	Spice Model	Hspice model name.	✓	✓	✓
lvs_model	LVS Model	LVS model name	✓	✓	✓
r	Resistance (Ohm)	Resistance value in ohms.	✓	✓	✓
w	Width (M)	Resistor width in meters.	✓	✓	✓
l	Stripe Length (M)	Length of each stripe of resistor a resistor.	✓	✓	✓

Parameter Name	Parameter Prompt	Description	Resistor Type		
			Metal	Poly Diffusion	Nwell
entryMode	Entry Mode	User can specify resistance and width (r & w) mode or length and width (l & w) mode or resistance and length(r & l) mode.	✓	✓	✓
series	Series Stripes	Indicates number of series stripes. This cannot be set simultaneously with parallel option. Only one form of stripes input is allowed.	✓	✓	✓
parallel	Parallel Stripes	Indicates number of parallel stripes. Cannot be set simultaneously with series stripes.	✓	✓	✓
spacing	Stripes Spacing	Indicates the required stripe spacing. Checked with minimum DRC allowed value.	✓	✓	✓
drawWell	Draw NWell	User has the option to Draw Nwell layer. Applicable only for P diffusion resistors.	X	✓	✓
dummyLegs	Dummy Legs	Check to enable dummy guard legs for the resistor. Options available: "Left", "Right" & "Both"	✓	✓	✓
guardRing	Guard Ring Type	Option to select the type on implant in the Guard Ring. Options: "P" or "N"	X	✓	✓
tapTop	Tie Top	Option to turn the guard ring on the top ON/OFF	X	✓	✓
tapRight	Tie Right	Option to turn the guard ring on the right ON/OFF	X	✓	✓
tapBottom	Tie Bottom	Option to turn the guard ring on the bottom ON/OFF	X	✓	✓
tapLeft	Tie Left	Option to turn the guard ring on the left ON/OFF	X	✓	✓
m	Multiplier	Multiplicity factor to place "m" number of parallel	✓	✓	✓

Parameter Name	Parameter Prompt	Description	Resistor Type		
			Metal	**Poly Diffusion**	**Nwell**
		devices.			
mtot	M Total	Total multiplicity factor, which is hidden from the end user.	✓	✓	✓
Leff	Effective Length (M)	Displays the effective length of resistor in layout.	✓	✓	✓
deviceType	Resistor Type	Type of Resistor (like poly, diff etc)	✓	✓	✓
DFMRules	DFM Rules	User can choose between "Minimum" and "Recommended" and "Custom". "Minimum" option follows foundry minimum rules. "Recommended" option will use the recommended minimum width and min number of squares (l/w) rule. "Custom" option takes the user defined values from the form.	✓	✓	✓
m1ContactEndcap	Metal1 Contact Endcap (M)	Option to set the value of the Metal 1 Contact Endcap enclosure to a value other than the minimum value.	X	✓	✓
polyContactEndcap	Poly Contact Endcap (M)	Option to set the value of the Poly Contact Endcap enclosure to a value other than the minimum value. This option is applicable only to poly type resistor.	X	✓	✓
diffContactEnclose	Diffusion Contact Enclose	Contact Enclosure by Diffusion value.	X	✓	✓

Units

By default, the units for the values entered for length and width are meters. The unit name postfixes are taken care of by Custom Designer.

Parametric Inputs/Values

All values entered must be integers or floating-point numbers or variables.

Resistor Netlist

A 2-Terminal Resistor netlist is as follows:

```
xr31 net107 net108 rm1 w='1u' l='3u' m=1
```

Resistor Device Specifications

The following table lists the permissible range for the CDF parameters:

Device	Length in µm		Width in µm		Sheet Resistance
	Min	Max	Min	Max	
rnpoly	0.8	1000	0.15	100	402.1
rppoly	1	1000	0.18	100	390.0
rndiff	2	1000	0.16	100	25.0
rpdiff	2	1000	0.18	100	40.0
rnwell	1	1000	1	100	330.0
rnwdiff	1	1000	1	100	550.0
rm1	0.1	1000	0.1	100	0.115
rm2	0.15	1000	0.15	100	0.086
rm3	0.15	1000	0.15	100	0.086
rm4	0.15	1000	0.15	100	0.04
rm5	0.15	1000	0.15	100	0.04
rm6	0.15	1000	0.15	100	0.04
rm7	0.15	1000	0.15	100	0.04
rm8	0.15	1000	0.15	100	0.04
rmt	0.15	1000	0.15	100	0.04

See Also

 Resistor: res_reference90RF_cbk.tcl in the Warnings and Error Messages section.

Capacitors

The following capacitors are supported in this PDK:

Device	Symbol / Pcell	Spice Model	Description
cmim_2t	cmim_2t	cmim	2 term Capacitor (PLUS MINUS)

This section covers the following topics:

- Symbol parameters
- Units
- Parametric Inputs/Values
- Capacitor Netlist
- Capacitor Device Specifications

Symbol parameters

The following table lists the parameters and their description:

Parameter Name	Parameter Prompt	Description
model	Spice Model	Hspice model name.
lvs_model	LVS Model	LVS model name
c	Capacitance (F)	Capacitance value. Its expressed in farads
l	Length (M)	Length of capacitor in meters.
w	Width (M)	Width of capacitor in meters.
entryMode	Entry Mode	Capacitance, length and width calculation based on the modes selected "c" or "l & w" or "c & w". Default mode is "c"
rows	Rows	Number of rows of the capacitor top plate
columns	Columns	Number of columns of the capacitor top plate
m	Multiplier	Multiplicity factor to place "m" number of parallel devices.
mtot	mtot	Total multiplicity used in simulation. (Rows*Columns)
ceff	Effective Capacitance	Displays the effective capacitance for the whole stack of capacitors

Parameter Name	Parameter Prompt	Description
tapTop	Tap Top	Controls top tap structure.
		Options: "all","diffusion","none"
tapRight	Tap right	Controls right tap structure.
		Options: "all","diffusion","none"
tapLeft	Tap left	Controls left tap structure.
		Options: "all","diffusion","none"
tapBottom	Tap Bottom	Controls bottom tap structure.
		Options: "all","diffusion","none"
guardRing	Guard Ring	Choice of including a Ptype or Ntype guard ring or neither.
		Options : "none", "P", "N"

Units

By default, the units for the values entered for length and width are meters. The unit name postfixes are taken care of by Custom Designer.

Parametric Inputs/Values

All values entered must be integers or floating-point numbers or variables.

Capacitor Netlist

A 2-Terminal Capacitor netlist is as follows:

```
xc0 PLUS MINUS cmim_2t l='1u' w='1u' m=1
```

Capacitor Device Specifications

The following table lists the permissible range for parameters:

Device	Length in µm		Width in µm	
	Min	**Max**	**Min**	**Max**
cmim_2t	1.0	100.0	1.0	100.0

See Also

General Warnings: ref90_common.tcl in the Warnings and Error Messages section.

Diodes

The following diodes are supported in this PDK:

Device	Symbol / Pcell	Spice Model	Description
pn	pn	PN	2-terminal (PLUS MINUS) P+/Nwell Low Volt DIODE
np	np	NP	2-terminal (PLUS MINUS) N+/Psub Low Volt DIODE
pn18	pn18	PN18V	2-terminal (PLUS MINUS) P+/Nwell 1.8 Volt DIODE
np18	np18	NP25V	2-terminal (PLUS MINUS) N+/Psub 1.8 Volt DIODE
nwdio	nwdio	NWDIODE	2-terminal (PLUS MINUS) NWell/Psub Low Volt DIODE

This section covers the following topics:

- [Diode CDF Parameters](#)
- [Units](#)
- [Parametric Inputs/Values](#)
- [Diode Netlist](#)
- [Diode Device Specifications](#)

Diode CDF Parameters

The following table lists the CDF parameters and their description:

Parameter Name	Parameter Prompt	Description
model	Spice Model	Hspice model name
lvs_model	LVS Model	LVS model name
l	Length (M)	Length of diode.It is expressed in meters
w	Width (M)	Width of diode It is expressed in meters
diodeLayer	Diode Layer	Option to turn (ON / OFF) the diode marker layer.
area	Area (sq. M)	Area of the diode region
pj	Perimeter (M)	Perimeter of the diode layer
m1ContactEndcap	Metal1 Contact	Option to set the value of the Metal 1 Contact Endcap enclosure to a value other

Parameter Name	Parameter Prompt	Description
	Endcap (M)	than the minimum value.
dioType	dioType	Type of diode (ndiff, pdiff, etc.)
m	Multiplicity (m)	Multiplicity factor
DFMRules	DFM rules	User can choose between "Minimum" and "Recommended" and "Custom".
		"Minimum" option follows foundry minimum rules. "Recommended" option will use the recommended minimum width. "Custom" option takes the user defined values from the form.
diffContactEnclose	diffContactEnclose	Contact Enclosure by Diffusion.

Units

By default, the units for the values entered for length and width are meters. The unit name postfixes are taken care of by Custom Designer.

Parametric Inputs/Values

All values entered must be integers or floating-point numbers or variables.

Diode Netlist

A 2-Terminal Standard Diode netlist is as follows:

```
N+/PW Diode
d16 net62 net63 NP area='1.21p' pj='4.4u' m=1
```

Diode Device Specifications

The following table lists the permissible range for the parameters:

Device	Length in μm		Width in μm	
	Min	**Max**	**Min**	**Max**
pn	1.1	100	1.1	100
np	1.1	100	1.1	100
pn18	1.1	100	1.1	100
np18	1.1	100	1.1	100
nwdio	1.1	100	1.1	100

See Also

in the Warnings and Error Messages section.

Custom Vias

The following Custom Vias are supported in this PDK:

Custom Via	Description
diff_cust	Diffusion Contact
poly_cust	Poly Contact
ndiff_cust	N-Diffusion Contact
pdiff_cust	P-Diffusion Contact
via12_cust	Metal1-Metal2 Via
via23_cust	Metal2-Metal3 Via
via34_cust	Metal3-Metal4 Via
via45_cust	Metal4-Metal5 Via
via56_cust	Metal5-Metal6 Via
via67_cust	Metal6-Metal7 Via
via78_cust	Metal7-Metal8 Via
via89_cust	Metal8-Metal9 Via

This section covers the following topics:

- Custom Via CDF Parameters

Custom Via CDF Parameters

The following table lists the CDF parameters and their description:

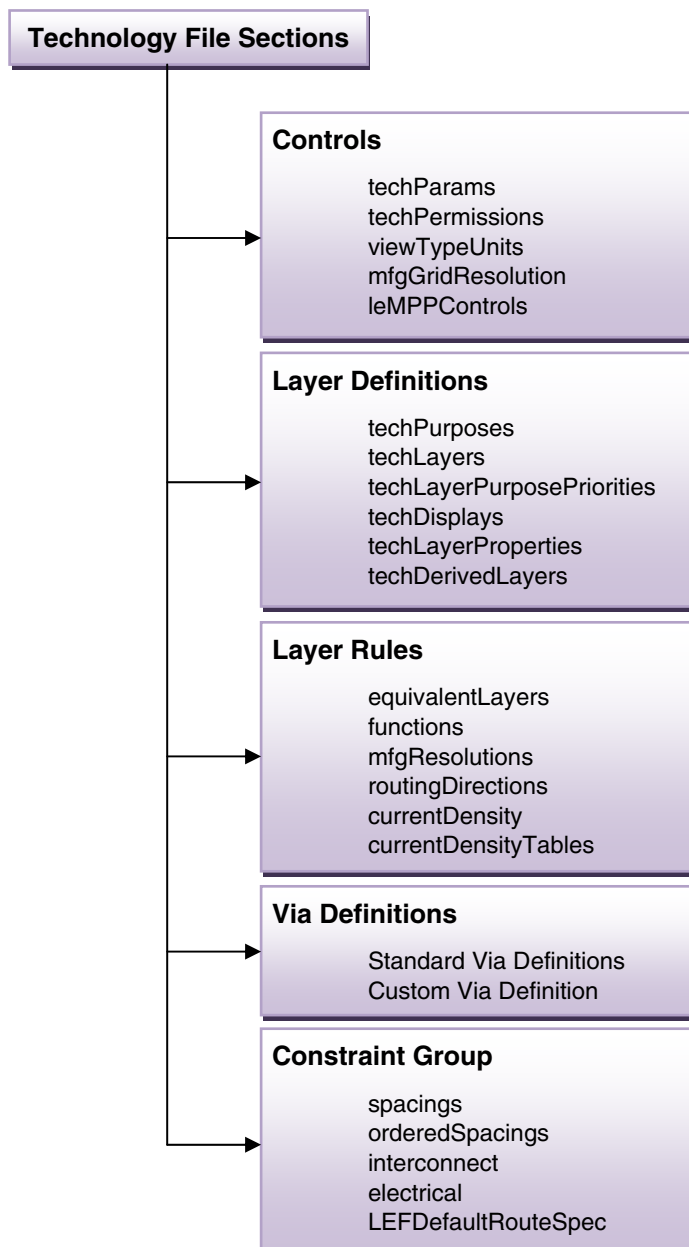| Parameter Name	Parameter Prompt	Description
x	width	Width of the region in which the custom vias are wanted.
y	length	Length of the region in which the custom vias are wanted.
lyr1ExtraEncX	Layer 1 enclosure in X – Dir	Value of Layer 1 enclose contact / via in X – Direction
lyr1ExtraEncY	Layer 1 enclosure in Y –	Value of Layer 1 enclose contact / via in

		Dir	Y – Direction
`lyr2ExtraEncX`	Layer 2 enclosure in X – Dir	Value of Layer 2 enclose contact / via in X – Direction
`lyr2ExtraEncY`	Layer 2 enclosure in Y – Dir	Value of Layer 2 enclose contact / via in Y – Direction

Technology File Overview

Technology data represents attributes of a design process, for use by Custom Designer or other Electronic Design Automation tools.

Custom Designer technology data includes both a technology file and a display resources file.

The technology data in the technology file includes the following major sections:

```
┌─────────────────────────────┐
│  Technology File Sections   │
└─────────────────────────────┘
```

Controls

- techParams
- techPermissions
- viewTypeUnits
- mfgGridResolution
- leMPPControls

Layer Definitions

- techPurposes
- techLayers
- techLayerPurposePriorities
- techDisplays
- techLayerProperties
- techDerivedLayers

Layer Rules

- equivalentLayers
- functions
- mfgResolutions
- routingDirections
- currentDensity
- currentDensityTables

Via Definitions

- Standard Via Definitions
- Custom Via Definition

Constraint Group

- spacings
- orderedSpacings
- interconnect
- electrical
- LEFDefaultRouteSpec

Additional Information

The section covers the following topics:

- [Instance Update Utility](#)
- [Preparing Hercules Runset for OpenAccess Compatibility](#)
- [Warnings Messages](#)

Instance Update Utility

An Instance Update utility is provided to update the instance parameter values in a design.

The following table lists the various options that you can use to update an instance:

If you want to trigger a callback…	then use the following option…
on instances placed in the view type of a given library name and cell name	`updateInst <libName> <cellName> <viewType>`
on instances placed in both the schematic and the layout view types (if exists)	`updateInst <libName> <cellName>`
on instances placed in all the cells of a given library	`updateInst <libName>`
on all instances in the active design (using getActiveContext)	`updateInst`

Preparing Hercules Runset for OpenAccess Compatibility

To make Hercules compatible with OpenAccess, modify the contents of the Milkyway Hercules runset (found in the 25MAR10/hercules/ folder) as follows:

```
HEADER {
      FORMAT = openaccess
      OUTPUT_FORMAT = MILKYWAY
}

OPENACCESS_OPTIONS {
      LIBRARY_MAPPING_FILE = ./lib.defs
      LAYER_MAPPING_FILE = <full path upto techfiles
      directory>/layer.map
}
```

Warnings Messages

This section discusses both generic and device specific warning messages displayed in the Custom Designer console:

- General Warnings: ref90_common.tcl
- MOSFET: mos_reference90RF_cbk.tcl
- Resistor: res_reference90RF_cbk.tcl

Note:

Devices such as Diodes, Capacitors and Custom Vias do not have any specific warning messages. The generic warning messages for these device types are documented in the General Warnings section.

General Warnings: ref90_common.tcl

Following is the list of generic warning messages:

When you…	Then…	Example
Enter an invalid value for a parameter	WARNING 0001	WARNING 0001> Parameter "Number of Fingers" value "1 1" is invalid, Resetting to default value
Enter a non-integer value for an integer parameter	WARNING 0002	WARNING 0002> Parameter "Number of Fingers" 2.5 not an integer. Resetting to integer value 2
Enter a value, which is not on grid, for a parameter, which should be on grid	WARNING 0003	WARNING 0003> Resetting parameter "Length" 0.1005u to 0.1u to be on grid.
Set a parameter to such a value so that a calculated dependent parameter value is less than its minimum value	WARNING 0004	WARNING 0004> For given "Resistance" 1, Calculated "Stripe Length" 35n < Min value 0.8u Resetting "Resistance" to limit "Stripe Length" to Min Value 0.8u
Set a parameter to such a value so that a calculated dependent parameter value is more than its maximum value.	WARNING 0005	WARNING 0005> For given "Capacitance" 1.994843826n, Calculated "Length" 1.3945800m > Max value 0.1000m Resetting "Capacitance" to limit "Length" to Max Value 0.1000m

When you…	Then…	Example
Enter a value, which is less than the parameter's minimum value	WARNING 0006	`WARNING 0006> "Width per Finger" 0.1u < Min value 0.12u` `Resetting "Width per Finger" to Min value`
Enter a value, which is more than the parameter's maximum value	WARNING 0007	`WARNING 0007> "Width per Finger" 100.0 > Max value 0.9000m` `Resetting "Width per Finger" to Max value`

MOSFET: mos_reference90RF_cbk.tcl

Following is the list of warning messages when working with MOSFETs:

When you…	Then…	Example

Enter the "Total Width" value for Number of Fingers such that the calculated Width Per Finger is less than its minimum value	WARNING 0101	`WARNING 0101> Calculated Width Per Finger (M) value 48n < minimum value  0.12u`
		
		`Resetting Number of Fingers 5 to 2.`

Enter the "Total Width" value for Number of Fingers such that the calculated Width Per Finger is off-grid	WARNING 0102	`WARNING 0102> Calculated Width Per Finger Value 0.5025u is Off grid,`
		
		`Resetting Total width 1.005u to 1u to make Width Per Finger on grid`

Set the "Place Tap on Top" option to "diffusion" when the "Tap Structure" option is "standard"	WARNING 0103	`WARNING 0103> When Tap Structure is standard, Parameter "Place Tap on Top" can't be diffusion.`
		
		`Resetting Parameter "Place Tap on Top" to all`

Set the "Tap Contacts" option to more than 1 when the "Tap Structure" option is "standard"	WARNING 0104	`WARNING 0104> When Tap Structure is standard, Parameter "Tap Contacts" can't be more than 1.`
		
		`Resetting Parameter "Tap Contacts" to 1`

Enter the "Total Width" value for Number of Fingers such that the calculated Width Per Finger is less than its minimum value	WARNING 0105	`WARNING 0105> Calculated Width Per Finger value (M) 80n < minimum value  0.12u`
		
		`Resetting Total Width (M) 0.16u to 0.24u.`

Enter "Tap Spacing" parameter value to less than grid value	WARNING 0106	`WARNING 0106> Parameter "Tap Spacing (M)" is less than minimum grid resolution 5n`
		
		`Resetting Parameter "Tap Spacing (M)" to 5n`

Try to set the Butted Tap option of 1 and 1.8 volt MOSFETs to other MOSFETs; it will be automatically turned OFF	WARNING 0107	`Parameter "Butted Tap" is not allowed for this model, turning it off.`

Resistor: res_reference90RF_cbk.tcl

Following is the list of warning messages when working with Resistors:

When you…	Then…	Example
Enter "Series Stripes" value such that the calculated dependent "Stripe Length" is less than its minimum value	WARNING 0201	WARNING 0201> Stripe length value 0.52u < min Length 0.8u, Resetting the number of Series Stripes 4 to 1.
Enter "Resistance" value such that the calculated dependent "Stripe Length" is more than its maximum value	WARNING 0202	WARNING 0202> Stripe length value 4.9241800m > max Length 1.00m, Resetting the number of Series Stripes 1 to 5.
Set the "Resistance" value to 0 when the entry mode is "r & l"	WARNING 0203	WARNING 0203> The resistor value cannot be Zero, Resetting to 400.059
Set the Width value such that the (Stripe Length)/Width ratio is less than the minimum number of squares	WARNING 0204	WARNING 0204> Foundry Recommended rules for Spice Model accuracy : Min.Squares (l/w) >= 1